POP-UP SPRINKLER

FIELD OF THE INVENTION

This invention relates to sprinklers and more specifically to so-called pop-up or riser sprinklers where the irrigation head assembly is spontaneously displaceable responsive to water pressure, between a retracted opposition, namely a non-active position, and an extracted position, namely an active position.

BACKGROUND OF THE INVENTION

A wide variety of pop-up sprinklers are known where a housing is typically berried under ground surface where the sprinkler is concealed for both aesthetic reasons and for practical ones, e.g. to facilitate easy lawn mooring, to prevent the sprinkler from being an obstacle to pedestrians, etc. In some cases a pop-up sprinkler is intended for increasing the irrigation range or for over coming obstacles such as a bush, a decorative stone, a fence, etc. These objects are however achieved by a substantially large housing with a corresponding long pop-up stem member, requiring suitable sealing means.

A different type of pop-up sprinklers is of the kind comprising a membrane deformable between a retracted position and an elevated position, responsive to water supply pressure. Such sprinklers are described, for example, in U.S. Patents 3,282,508 to Bailey and 4,919,332 to Roberts.

It is an object of the present invention to provide a pop-up sprinkler fitted with an improved raising mechanism which one the one hand is inexpensive and easy to assemble and, on the other hand, offers many advantages such as compact structure, smooth and trouble-free operation, insect and dirt protection, inverted

installation ('*top down*'), etc. Furthermore, the sprinkler according to the present invention offers many diversities for various purposes. For example, the sprinkler may be integrally fitted with a flow control assembly and a leak preventing device, with an in-line filter, etc.

SUMMARY OF THE INVENTION

According to the present invention there is provided a sprinkler comprising a housing fitted with an inlet port connectable to a water supply line and extending into an inlet chamber, a hollow stem member having with an inlet end thereof being in flow communication with said inlet chamber and an outlet end thereof being in flow communication with an irrigation head; a diaphragm seal sealingly fixed at peripheral boundaries thereof to the housing and sealingly articulated to the stem member and supporting it at an essentially upright position; said diaphragm being deformable between a first position in which the irrigation head is retracted within the housing and a second position in which the irrigation head projects from the housing.

The sprinkler displaces into its open, extended position by hydraulic forces, i.e. hydrostatic force rather than reactionary forces of water impinging against a surface of the irrigation head.

According to some embodiments of the invention, the diaphragm seal is beveled, however according to other embodiments the diaphragm seal may have other shapes. e.g. a flat disk, a conical disc, a gradually beveled disc, etc. However, where the diaphragm seal has a non-flat section (e.g. beveled/conical section - collectively referred to hereinafter as a *beveled* diaphragm seal), it offers some advantages.

A beveled diaphragm seal toggles into its respective first and second positions and according to a particular feature of the sprinkler of the present invention, the beveled diaphragm seal is substantially un-tensed at either of its two respective beveled positions. According to one specific arrangement, at its second beveled position the beveled diaphragm seal bears against a supporting surface

.where the beveled diaphragm seal bears against the inclined surface and under water pressure provides hydraulic seal.

When the diaphragm seal is beveled, it may be used to generate an axial force giving rise to a biasing effect e.g. for sealing a leek preventing device (LPD) fitable at an inlet of the sprinkler, whereby a spring may be used or eliminated.

According to modifications of the invention, rather then a beveled diaphragm there may be provided a rolling type membrane or a peel away type diaphragm.

Furthermore, axial displacement of the stem member is restricted, thereby restricting stress of the beveled diaphragm seal. Axial displacement restriction is obtained, for example, by a projecting shoulder of the stem member engageable with a corresponding bearing surface of the housing.

Furthermore, the housing is formed with a radial support to facilitate only axial (sliding) displacement of the stem member, thereby preventing rotary displacement and reducing generation of forces to the diaphragm seal.

According to the present invention, the sprinkler further comprises a cover member articulated to one of the stem member and the irrigation head, whereby the shielding portion is closable by said cover member at the first position. By one embodiment, the shielding portion is formed with one or more drain ports and still, the one or more drain ports are sealable at the first position. The arrangement according to one embodiment is such that at the second position a portion of the stem or of an articulated bridge portion displaces into sealing engagement with the one or more drain ports.

The sprinkler according to the present invention is formed, according to one of its embodiments, with a radial support to facilitate only axial displacement of the stem member. Such a radial support may be in the form of an annular neck portion or support ribs or segments, integrally formed with the housing or fixed thereto, slidingly supporting the stem member.

According to another embodiment of the present invention the inlet chamber is fitted with a flow control assembly comprising a flexible membrane retained

within the inlet chamber which responsive to pressure differential thereover is deformable to constrict the cross section area of a liquid flow path into the inlet end of the stem member.

The arrangement according to a particular application is such that at the first beveled position the flexible membrane bears against the inlet port, thus serving as a leak preventing device, ensuring the inlet port is sealed until water pressure at the inlet port reaches a minimal nominal pressure.

The sprinkler according to the present invention also offers a positively sealed sprinkler, at all positions thereof, a sealing of draining ports at the closed, retracted position of the sprinkler and drainage of said draining ports at the open, extracted position of the sprinkler.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, some embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Figs. 1A-1D are directed to a first embodiment of a sprinkler in accordance with the present invention wherein:

Fig. 1A is an exploded isometric view;

Fig. 1B is a sectional elevation of the sprinkler in the so-called closed position; and

Fig. 1C is a sectional elevation of the sprinkler in the so-called open position;

Fig. 1D is an isometric view from below of a stem member integrated with a filter;

Fig. 2A is a longitudinal isometric section of the stem member useful in a sprinkler in accordance with the present invention;

Fig. 2B is a section along line II-II in Fig. 2A;

Figs. 3A and **3B** are sectioned side views of a stem, bridge and irrigation head according to a modification of the invention, at an exploded view and an assembled view, respectively;

Figs. 4A to **4C** are sectioned exploded side views illustrating three alternatives of applying an outlet nozzle in accordance with modifications of the embodiment of Fig. 1;

Figs. 5A-5C are directed to a sprinkler in accordance with a second embodiment of a sprinkler in accordance with the present invention, wherein:

Fig. 5A is an isometric exploded view of the sprinkler;

Fig. 5B is a longitudinal sectional view of the sprinkler in its closed position; and

Fig. 5C is a longitudinal section of the sprinkler in its open, pop-up position;

Fig. 6A-6C illustrate a sprinkler in accordance with still another embodiment of the irrigation present invention wherein:

Fig. 6A is a perspective exploded view of the sprinkler;

Fig. 6B is a longitudinal section of the sprinkler in the closed position; and

Fig. 6C is a longitudinal section of the sprinkler in the pop-up position;

Figs. 7A and **7B** illustrate a sprinkler according to a modification of the invention, wherein:

Fig. 7A is a longitudinal section of the sprinkler at its closed/retracted position; and

Fig. 7B is a longitudinal section of the sprinkler at its open/operative position, rotated about 90° with respect to the presentation of Fig. 7A;

Figs. 8A and **8B** illustrate a sprinkler according to still another a modification, wherein:

Fig. 8A is a longitudinal section of the sprinkler at its closed/retracted position; and

Fig. 8B is a longitudinal section of the sprinkler at its open/operative position.

DETAILED DESCRIPTION OF THE INVENTION

Attention is first directed to Figs. 1A to 1C illustrating a pop-up sprinkler in accordance with the present embodiment generally designated **20**. The sprinkler comprises a housing **22** fitted with a bottom cap **24** for screw engagement therewith, the latter comprising an inlet port **26** extending into an inlet chamber **30**. In assembly of the sprinkler **20**, the cap **24** screw clamps a beveled diaphragm seal **34** at a peripheral boundary rim **36**, thus retaining the beveled diaphragm seal **34** in place within the housing.

The beveled diaphragm seal **34** is formed with a central aperture **38** wherein the inner peripheral boundaries **40** are annularly arrested within an annular groove **42** of a hollow stem member generally designated **44**, supporting the latter in an essentially upright position such that an inlet end thereof **46** extends below the beveled diaphragm seal **34** and an outlet end thereof **48** extends above the beveled diaphragm seal **34**, as can be seen in Figs. 1B and 1C.

The annular groove **42** is formed between a first annular shoulder **50** and a second annular shoulder **52** with a coiled spring **56** having one end thereof bearing against annular support **52** with an opposed end thereof bearing against an opposite annular portion **58** of the housing **22**, thus biasing the beveled diaphragm seal **34** and the associated stem **44** into a downward, retracted position as in Fig. 1B.

A bridge member **62** is screw coupled or otherwise articulated to the stem member **44** (e.g. by snap fitting etc.), said bridge **62** having a top cover portion **64** sized and shaped to close a top opening **66** of housing **22**. The bridge member **62** is fitted with a locking piece **68** engagable by means of arresting ribs **70A** and **70B** projecting from the bridge member **62** and the locking piece **68**, respectively. A reactionary rotatable irrigation head **80** comprises an inlet portion **82** is rotatably received within a receptacle at the outlet end **48** of the stem member **44** and the head is formed with an axially projecting boss **86** rotatably supported within an opening **88** formed in the support piece **68**, the arrangement being such that the irrigation head **80** is rotatably supported with little friction whereby it freely rotates

owing to reactionary forces developing upon water flow about a reactionary surface **92** (Figs. 1B and 1C).

The beveled diaphragm seal **34** (Fig. 1A) is normally at either of its beveled positions, i.e., a first position as in Fig. 1B when the irrigation head **80** is retracted and does not project from the housing **22**, and a second position, as in Fig. 1C wherein the irrigation head projects from the housing in its operable position. The beveled diaphragm seal **34** is un-tensed at either of its two respective beveled positions. The diaphragm seal **34** comprises a normally beveled portion designated **92**, with an annular resilient portion **94** extending between the peripheral portion **36** and the beveled portion **92**, where deformation of the beveled diaphragm seal **34** occurs mainly about said annular resilient portion **94** in a toggle-fashion.

Furthermore, as seen in Figs. 1B and 1C, the housing **22** is formed with a diaphragm seal support portion **96** having a shape corresponding with that of the beveled diaphragm seal **34** in its second position such that at said second position the diaphragm seal **34** bears against said surface **96** to ensure the diaphragm beveled seal **34** is not tensioned, as in Fig. 1C. This arrangement ensures that substantially no tension is applied to the beveled diaphragm seal and accordingly, a relatively thin and inexpensive such seal may be used. Bearing of the beveled diaphragm seal against the corresponding inclined surface **96** of the housing **22** also provides for hydraulic seal, increasing seal contact.

It is further noted that at the second position, the axial displacement of the stem member **44** is restricted by the annular projecting shoulder **52** encountering a corresponding shoulder **53** of the housing **22** to thereby prevent tensioning or stressing of the beveled diaphragm seal **34**.

Although not illustrated in the drawings, it is appreciated that the suitable rotary dampeners may be used, e.g. a viscose dampener (of the type comprising a viscous substance such as silicone), etc. For example, such a dampener may be incorporated in the locking piece **68**.

With particular reference to Figs. 1B and 1C, the housing **22** is formed with an annular support neck portion **57** for slidingly supporting the stem member **44**,

allowing it to displace only in an axial direction without any tilt or rotation. Rather then the annular portion **57**, there may be formed several ribs or segments (not shown) supporting the stem member.

As can further be seen in the figures, the housing **22** is formed with a shielding portion **98** which accommodates the irrigation head and which at the retracted position (Fig. 1B) is closed by means of bridge member **62**. The shielding portion **98** is formed with two drain ports **100** (only one of which is seen in Fig. 1A). The arrangement is such that at the second position, namely the operative position of the sprinkler, the drain ports **100** are opened to ensure proper drain of the housing. However, when the sprinkler is in its retracted position, as in Fig. 1B, the drain ports **100** seal by means of a corresponding sealing portion **104** coming to rest against the drain ports **100**. In this position the housing is sealed and protects the assembly from dirt and insects.

As can further be seen, the cap **24** is fitted with an extension piece **110** accommodating an integral filter **112** retained in place by a connecting piece **114** suited for pressure fit to a water supply tube (not shown). The cap member **24** is further formed with a support **116** for mounting on a post (not shown) at any desired position either suspending from above at an inverted position (the bridge member **62** facing downwards) or at an upright position as in the figures.

Sprinkler **20** further comprises a flow control assembly generally designated at **120** comprising a flexible disc-like membrane **122** retained within the inlet chamber **30** by retention leg members **126** (rotary motion being restricted by radial projection **127** extending from housing **24**) with an inlet passage **130** formed between the legs **126** to ensure flow communication about both faces of the membrane **132**. Legs 126 further prevent rotary displacement between the stem member **44** and the cap **24**.

A particular application of the invention is illustrated in Fig. 1D, wherein like elements as in Figs. 1A to 1C are designated like reference numbers with a prime (')indication. The stem member generally designated **44'** is similar to that seen in Figs. 1A to 1C, and comprises an inlet port **46'**, an annular groove **42'**

formed between a first annular shoulder **50'** and a second annular shoulder **52**, retention leg members **126'** with an inlet passage **130'** formed therebetween, wherein said second annular shoulder **52'** is formed with a plurality of openings **127** opening into the flow control assembly **120** thus forming an integral filter unit. It is noted that the openings **127** are wider at their inner end, to prevent dirt from clamping therein.

In use, the sprinkler is normally at its closed position as in Fig. 1B, wherein the beveled diaphragm seal **34** is at its first beveled position and the irrigation head **80** is retracted and does not project the housing **22**, owing to the biasing effect of coiled spring **56**. However, upon introducing water pressure through inlet port **26**, pressure develops within the inlet chamber **30** resulting in toggle deformation of the beveled diaphragm seal **34** into its second position (as in Fig. 1C) entailing corresponding displacement of the stem member **44** along with the associated irrigation head, whereby water flows through the lumen **136** of the stem member **44** flowing out through the outlet end **48** into the irrigation head **80** and causing it to rotate under influence of reactionary forces developing about reactionary surfaces **92** so as to radially admit water in the gap **140** formed between the cover portion **64** of bridge member **62** and a top edge **144** of the housing **22**.

Upon ceasing the water supply through inlet port **26** the pressure within the inlet chamber **30** decreases and under influence of the coiled spring **56** the beveled diaphragm seal **34** toggles back into its first position (Fig. 1B) with the bridge member **62** closing the housing **22** and the drain ports **100** being sealed with corresponding portion **104** as discussed hereinabove.

The flow control assembly **120** acts as a differential pressure assembly wherein the membrane **122** deforms responsive to pressure differential between its inlet face and its outlet face to thereby vary the through flow into the inlet end **46** of the stem member **44**, thereby restricting water flow therethrough.

The sprinkler disclosed hereinabove is of simple construction and is easy to assemble and disassemble for maintenance. Furthermore, an outlet nozzle of different nominal outlet flow may be fitted at an outlet end **48** of the stem

member **44**. For example, each nozzle may be of a different color corresponding with its nominal through-flow. The replaceable nozzles may have a nominal outlet flow of say between 25 to 200 liters/hour.

It is further appreciated that the beveled diaphragm seal **34** divides the housing into a pressurized zone at a side thereof facing the inlet port, and an essentially atmospheric pressure zone at its other side.

In Figs. 2A and 2B there is illustrated an alternative embodiment of a stem member in accordance with the present invention generally designated **160** being substantially similar to the stem member **44** referred to in Figs. 1A-1C with the exception that its lumen **162** is formed adjacent the outlet end **164** with a flow straightening arrangement **166** in the form of fins **168** (referred to in the art also *as straightening vanes*) extending radially inwards for imparting the water flowing through the lumen **162** a regular smooth flow towards its outlet through the outlet end **164**. The zone in the lumen **162** extending below the fins **168** is referred to as the '*quiet zone*'.

It is also noted in Fig. 2A that the outlet end **164** of the stem member **160** is formed with a receptacle suited for receiving the irrigation head (not seen) or a flow restricting nozzle (orifice), as discussed hereinbefore.

Diaphragm **122** of the flow control assembly **120** serves also as a leak preventing device (LPD) i.e. before build up of a minimal pressure, the diaphragm **122** bears against the nozzle end **131** of inlet port **26** (see Fig. 1B) in a sealing manner. The LPD also prevents suction of dirt, sand, etc into the water supply line.

The drain ports **100** are formed at a lower portion of the cone-like shielding portion **98**, ensuring drainage of water therefrom.

Turning now to Figs. 3A and 3B there is illustrated only a portion of a sprinkler according to a modification of the embodiment of Figs. 1A to 1C and accordingly like elements are given like reference numbers with a prime (') indication. According to this modification, the stem member **44'** is fitted at its outlet

end **48'** with a receptacle **49** rotatably receiving the irrigation head **80'**, the later comprising an inlet portion **82'** rotatably received within receptacle **49**, and at its opposite end there is formed a bore **81** rotatably receiving a corresponding boss **83**, projecting from bridge member **62'** or inversely, as disclosed in connection with Figs. 4A to 4C.

Other arrangements are possible to, such as, for example, applying a rotation dampener (not shown) such as a silicone dampener fitted at either the bridge member or the irrigation head, as known *per se*.

In accordance with some other embodiments of the invention an outlet nozzle of the sprinkler may be fitted at different locations and at different combinations. A first example is illustrated in Fig. 4A, corresponding with the embodiment of Figs. 1A to 1C, where same elements are given same reference numbers. According to this embodiment the outlet nozzle **167** is formed integral with the stem member **48**, by means of a narrowing portion thereof.

A second embodiment is illustrated in Fig. 4B, where stem member **169** is fitted with a threaded outlet end **170** for coupling thereto a bridge member **171** formed (integrally or fixedly attached thereto) with a nozzle **172** of specific nominal flow rate. The irrigation head **173** is formed with an axial projection **174** rotatable within a receptacle **175** of the bridge member **171**, and further with an axial boss **176** rotatably supported by a locking piece **177** fastened to the bridge member **171**.

According to the embodiment of Fig. 4B, it is apparent that the bridge member/cover generally designated **171** has in fact several different functions, namely:

- Sealing/closing the shielding portion of the housing;
- Serving as a bridge for supporting the irrigation head at an end thereof remote from the outlet nozzle (in several different configurations, as discussed above);
- Comprising the outlet nozzle;
- Rotatably supporting the irrigation head; and

- Sealing/closing draining ports of the housing at the first (retracted) position to prevent insect and dirt ingress, whilst opening the drain ports at an irrigating position.

The irrigation head, as seen in the various embodiments of the present invention, is formed as part of the cover of the housing (integral therewith, or assembled thereto). Further, the irrigation head substantially does not axially displace with respect to the stem member and the cover, thereby retaining stability and bearing features.

It is appreciated that the bridge member may be articulated to the stem member in other versions, e.g. bayonet coupling, snap-type connection, etc. Furthermore, it is this arrangement that makes it possible to provide bridge members each fitted with a nozzle having a different nominal flow rate, distinguishable from one another, e.g. by different colors of the bridge member.

A third example is illustrated with reference to Fig. 4C where like elements are identified by same reference numbers as in Fig. 4B with a prime (') indication. According to this embodiment the stem member **169'** is fitted at its outlet end **170'** with a nozzle receptacle **187'** for securely receiving a replaceable outlet nozzle **189'**. Bridge member **171'** is screw coupled over the stem **169'** and retains the replaceable outlet nozzle **189'** in place. Bridge member **171'** is formed with a receptacle **191'** rotatably receiving the irrigation head **173'**, the later comprising an inlet portion **174'** rotatably received within receptacle **191'**, and at its opposite end there is formed a boss **176'** rotatably received within a corresponding receptacle of a locking piece **177'** fastened to the bridge member **171'**. According to one other modification (not shown), the irrigation head **173'** may be rotatably supported within a suitable cavity formed at the end of outlet nozzle **189'**, when the later is received within the stem member **169'**.

It is preferable, however, that the flow rate of the outlet nozzles should correspond with the nominal performance of the flow control assembly and accordingly, it would be advantageous that there be provided indication means for such correspondence, e.g. matching colors or colored portions of the bridge and the

housing, dedicated connections e.g. bayonet connections suitable for only one type of outlet nozzles, etc.

Further attention is now directed to Figs. 5A to 5C of the drawings directed to a different embodiment of the present invention, in this case concerned with a bridge-less sprinkler generally designated **180**. Apart from the housing **182** being somewhat different in its general appearance, the sprinkler has practically the same components as of the previous embodiments and the main difference resides in the structure of the stem member and the irrigation head collectively are referred to at **186** comprising a stem member **188** which has an inlet and similar to that disclosed in connection with the embodiment of Figs. 1 and a shorter stem portion **190** fitted at its outlet end **192** with several inwardly projecting bulges **194** separated from one another by axial slots **196** imparting the structure some resilience.

An extension stem member **200** has a cylindrical portion **202** receivable within the outlet end **192** of stem member **88** and formed with an annular groove **204** snapingly engagable by projections **194**.

Rotatably mounted on the extension stem member **200** there is a swivel **210**, in the form of a rotary bushing, freely rotatable about a cylindrical outlet end **214** of the extension stem member and snapingly retained thereto by means of an inward radial projection **218** snapingly retained by a corresponding annular recess **220** formed on the extension stem member **200**.

A reactionary rotatable sprinkler head **224** is formed with a disc-like cover **226** fitted for closing the shielding portion **228** of the housing **182** at the retracted position of the sprinkler (first beveled position) as seen in Fig. 5B, and further it comprises an engagement portion **232** fitted with an annular radial projection **234** snapingly engagable over an annular groove **236** of the swivel **210**. The sprinkler head **224** is further formed with a reactionary water flow path **240** giving rise to generating rotary motion upon water flow through that surface.

At the retracted position (Fig. 5B) the beveled diaphragm seal **242** is in its first beveled position under biasing influence of coiled spring **246** in where the inlet port **248** is sealed by flexible diaphragm **250** of the flow control assembly, as

explained in connection with the previous embodiment. However, upon introducing water pressure through the inlet port **248**, the beveled diaphragm seal **242** toggles into its second beveled position, as in Fig. 5C, resulting in corresponding axial displacement of the irrigation head assembly **246** into the position of Fig. 5C such that water emitted from the reactionary rotatable sprinkler head **224** can easily flow in the gap **250** between an edge **252** of housing **182** and the closing portion **226** of the sprinkler head **224**.

The outlet end **214** and the sprinkler head **224** are axially fixed with respect to one another and may also be integrated with respect to one another.

The embodiment of Figs. 6A to 6C is also directed to a bridgeless sprinkler generally designated **266** and which is significantly similar to the embodiment of Figs. 5A-5C with the exception of the irrigation head assembly **267** directed to a different embodiment of articulating the reactionary rotatable sprinkler head **268** to the stem member **270**. Accordingly, the reader is referred to the detailed description of the previous embodiments describing in detail the other components of the sprinkler. Fig. 6A is an exploded view of the sprinkler **266** and Figs. 6B and 6C are longitudinal sections of the sprinkler in a closed and an open position, respectively.

The stem member **270** has a short outlet stem portion **272** fitted adjacent its outlet end with inwardly projecting radial snap segments **276** for snap engagement within an annular groove **278** of an extension stem member **280** having a cylindrical portion **282** received within the stem portion **272**. Snapingly mounted on an opposite end of the extension stem member **280** there is fitted a swivel **286** snapingly engagable about an annular groove **288** of the extension stem member **280**.

The swivel **286** is fitted with two axial projecting legs **290** each formed at its free end with a laterally projecting lug **292** suited for snapingly engagement within corresponding apertures **294** formed in a reactionary rotatable sprinkler head **268**.

The arrangement is such that once the reactionary rotatable sprinkler head **268** is mounted on the swivel **286** it prevents the swivel from unintended disengagement from the extension stem member **280** in that it embraces the

legs **290** though allowing sufficient freedom for the swivel to rotate about the extension stem member.

It is noticed that the sprinkler head **268** has two rotational degrees of freedom, i.e. one imparted by the swivel **286** freely rotatable about the extension stem member **280** and the other imparted by extension stem member **280** rotatable within the stem member **270**. It is further noticed that the snapping portions are typically non continuous thus being formed with grooves so as to dispose of dirt, sand grains, weeds, algae, etc.

A person versed in the art will appreciate that other aspects which have already been disclosed in connection with the first embodiment disclosed in Figs. 1 and 2 may just as well be applied also in the embodiments of Figs. 2 and 6 e.g. the flow control assembly, liquid preventing device (LPD), flow rectifier, stem support arrangement, etc.

It is further noticed, although not mentioned in connection with the embodiments of Figs. 5 and 6, that the beveled diaphragm disc, in its second beveled position (Figs. 5C and 6C, respectively) bear against corresponding support surfaces of the housing such that the beveled diaphragm seal is not tensed in this position.

Furthermore, whilst not illustrated, it is appreciated that the sprinklers in accordance with the embodiments of Figs. 5 and 6 may also be provided with draining ports which may or may not be sealed in the retracted position.

Further attention is now directed to the embodiment of Figs. 7A and 7B, illustrating a rotary sprinkler **300,** where the housing comprises a base member **302** screw coupled to a body portion **304** of the housing, clampingly securing a first rimmed edge **308** of a ziggurat-like diaphragm seal **310,** where a second rimmed edge **314** thereof is securely retained to a stem member **316** by a fastener **318.** The body portion **304** of the housing comprises an inner surface **320** corresponding in shape and dimensions with that of the diaphragm seal **310,** to thereby support it at the extracted/operative position (Fig. 7B), thereby substantially eliminating tension force within the diaphragm seal **310** as already explained herein before.

It is further noted that the diaphragm seal **310** in its first position (Fig. 7A) resembles a bellows, which upon deformation to its second position (Fig. 7B) substantially does not undergo elastic deformation. It is seen that the diaphragm seal comprises first portions **324** (substantially vertically extending in both positions), and second, inclined portions **328** where deformation between positions is particularly by change of inclination of the inclined portions **328,** however without tensioning thereof.

Stem member **316** is supported within the housing **304** and is restricted to axial displacement only, by means of annular support **330** (which as already mentioned hereinabove may be in the form of radial fins, sectorial segments, etc). Furthermore, there is a coiled spring **333** biasing stem member **316** and the associated irrigation head **336** into the retracted/closed position (Fig. 7A). In this position seal **338** of the flow control assembly **340** sealingly engages the inlet port **342** formed at the base member **302** of the housing, thus serving as a leak preventing device (LPD). Also noted, the housing **304** is formed with an axial displacement restricting portion **344** in the form of an annular shoulder, which restricts axial displacement of the stem **316** and thus of the diaphragm seal **310,** to thereby substantially prevent tensioning thereof in the second, operative position (Fig. 7B).

Another application of the invention is illustrated in Figs. 8A and 8B of the drawings directed to a rotary sprinkler **380,** being similar to the construction of the sprinkler **300** of Figs. 7A and 7B, apart from the diaphragm seal **386.**

In the present embodiment the diaphragm seal **386** is clamped at a first rimed portion **388** between a seat **390** of the housing **392** and a screw coupled base member **294.** A rimmed portion **398** at an opposite end of the diaphragm seal **386** is secured to the stem member **400** and retained by a retention ring **404.**

Other components of the sprinkler **380** are similar as those described in connection with sprinkler **300** of Figs. 7A and 7B, however with the exception that the diaphragm seal **386,** in its first position, namely the retracted position of Fig. 8A, is pre-tensed to thereby apply a biasing force to retract the stem member **400**

and the components articulated thereto, whilst at the second position, namely the operative position as in Fig. 8B, the diaphragm seal **386** is tensed and deformed under water pressure to facilitate displacement of the stem into the second position. This arrangement obviates the need to provide a biasing spring as in some of the previous embodiments, for retracting the sprinkler into the retracted, first position.

In the position of Fig. 8B an annular shoulder **412** of the stem member **400** bears against a corresponding stopper shoulder **414** of the housing **392,** to thereby restrict its axial displacement.

Whilst in the position of Fig. 8B the diaphragm seal **386** does not bear against the corresponding wall portion of the housing, this can easily be achieved by forming a suitable indention for accommodating the retention ring **404.**

Part for the above differences, operation of the sprinklers 300 and 380 illustrated in Figs. 7A; 7B and 8A; 8B, respectively, is similar to that disclosed in connection with the previous embodiments and reference is made to the relevant passages of the specification. Other components and structural features of the sprinkler, may be similar to those already disclosed hereinabove, e.g. flow/pressure control assembly, drain ports, type of irrigation head (i.e. static, rotational, bridge or bridgeless, dampened, etc), mounting, flow straitening fins (**337** in Fig 7A) etc.

It is appreciated that the above descriptions are intended only to serve as examples and that many other embodiments are possible, all of which fall within the spirit and the scope of the present invention. For example, the irrigation head may be static or rotational, there may be provided dampening means, etc. Furthermore, the sprinkler according to the present invention may be fitted for an upright position or an inverted position ('top down'), where suitable suspension means may be provided.